

Appl. No. 10/614481
Amdt. dated January 14, 2005
Reply to Office Action dated October 14, 2004

Amendments to the Drawings:

The attached sheets of drawings includes changes to Fig. 4. The sheet, which includes Fig. 4, replaces the original sheet including Fig. 4. Figure 4 was corrected to include a legend designating the drawing as Prior Art.

The attached sheets of drawings includes changes to Fig. 5. The sheet, which includes Fig. 5, replaces the original sheet including Fig. 5. Figure 5 was corrected to include a legend designating the drawing as Prior Art.

The attached sheets of drawings includes changes to Fig. 7. The sheet, which includes Fig. 7, replaces the original sheet including Fig. 7. Figure 7 was corrected to include a legend designating the drawing as Prior Art.

Attachment: Replacement Sheets.

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REMARKS

Applicant thanks the Office for the attention accorded the present Application in the October 14, 2004, Office Action. In that Action, the Office rejected Claim 10 under 35 U.S.C. §112, second paragraph, as being indefinite, and Claims 1-19 were rejected under 35 U.S.C. §103(a) as being unpatentable over Black et al. in view of European Patent 182,656 A2 (EP '656).

The Office also objected to drawing Figures 4, 5, and 7 for not including a legend designating the drawings as Prior Art. Applicant is submitting substitute drawing sheets illustrating Figures 4, 5, and 7 as being labeled as Prior Art.

35 U.S.C. §112, second paragraph, rejections

The Office has rejected Claim 10 as being indefinite for failing to particularly point out and distinctly claim the subject matter which the applicant regards as the invention. The Office states that Claim 10 depends from itself.

Applicant has amended Claim 10 to depend from Claim 9. The amended dependency from Claim 9 now makes it clear that Claim 10 properly depends from Claim 9, not from itself, and Claim 9 provides proper antecedent basis for Claim 10.

In light of the above amendment and arguments, Applicant respectfully submits that the 35 U.S.C. §112, second paragraph, rejection of Claim 10 has been successfully traversed. Allowance of Claim 10 is therefore requested.

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35 U.S.C. §103(a) rejections

The Office has rejected Claims 1-19 under 35 U.S.C. §103(a) as being unpatentable over Black et al. in view of European Patent 182,656 A2 (EP '656). The Office states that Black discloses a magnetic assembly and a method of making a multistage magnetic rotary seal comprising a shaft having plural ridges, an annular magnet, a first pole piece and a second pole piece. Further, each pole pieces has plural ridges along an inner diameter that are spatially opposed to the ridges on the shaft. Additionally, the ridges can be of any shape (col. 10, lines 20-23). The Office also states that Black does not disclose a trapezoidal shape having tapered sides diverging (at an angle between 0 and 180 degrees) from a top plateau to an annular region.

The Office states that EP '656 discloses a magnetic assembly having a shaft, magnet, and two pole pieces and teaches art equivalent shapes for ridges forming stages. Particularly, Figure 8 teaches a trapezoidal shape having tapered, diverging sides from a plateau portion where the sides diverge at an angle between the required range. The Office contends that it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the shape of the ridges to a trapezoidal shape as such is an art equivalent shape (i.e. to a rectangular shape) as taught by EP '656. Applicant respectfully traverses.

The EP '656 disclosure teaches a ferrofluid rotary exclusion seal apparatus and method of employing a controlled gradient magnetic flux field. The pole pieces, which form the radial gap with the surface to be sealed (the shaft), includes a taper, step, or

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an end structural configuration that provides a controlled and reduced magnetic field gradient in the radial gap. EP '656 further teaches that this step or taper in the pole pieces alters the magnetic flux distribution in such a way that the ferrofluid surfaces do not experience a large magnetic field gradient.

The EP '656 disclosure, however, also teaches that use of a trapezoidal-shaped design also slightly decreases the pressure capacity over that of standard exclusion seals. The EP '656 disclosure states:

The ferrofluid exclusion seals of the invention and method of providing such seals by reducing the field gradient are particularly useful as exclusion seals wherein the pressure capacity of the seal is not a critical design factor and wherein a slightly lower pressure capacity over the standard exclusion seal is permissible, . . . (Page 24, lines 18-24)(emphasis added).

Because the EP '656 disclosure states that the structure of the seals are useful where pressure capacity is not critical and where a slightly lower pressure capacity over the standard seals is permissible, the EP '656 disclosure implies that the tapered seal structure is inferior to the standard, square seals because of the overall weaker seal capacity. Therefore, EP '656 teaches that while there are other benefits of the tapered or step pole piece design, providing the same or higher pressure capacity of those of standard seals is not one of the benefits.

In essence, EP '656 teaches away from using a tapered pole piece when designing a seal in which increased pressure capacity is needed because the tapered shaped, particularly the trapezoidal shape, will lower the pressure capacity of the seal.

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There is no motivation then, to combine the multistage magnetic rotary seal of Black et al. with the trapezoid shape design taught in EP '656 when slightly lower pressure capacity cannot be tolerated. In fact, the EP '656 disclosure states (as quoted above) that the trapezoid design is useful in applications where the pressure capacity of the seal design is not critical. Conversely, the trapezoid design should not be used where the pressure capacity of the seal is critical.

Where pressure capacity is a critical factor in seal design, one of ordinary skill in the art would not look to the teaching of the EP '656 disclosure. In fact, one of ordinary skill in the art would consider the EP '656 disclosure as teaching away from the use of trapezoidal seal stage designs where seal pressure capacity is a critical factor since the EP '656 disclosure states that the trapezoidal design provides a slightly weakened pressure capacity.

Applicant's invention, however, provides a magnetic fluid seal with improved pressure capacity. Applicant discloses an unexpected result with using opposing trapezoidal-shaped stages. This unexpected result is even more impressive in light of the teaching of the EP '656 disclosure.

A comparison of the data in Applicant's Tables 1 (dual trapezoidal stage design) and 3 (dual rectangular stage design) indicates a 46.5 percent increase in stage pressure capacity. In paragraph [0050], Applicant discloses the use of sixteen double trapezoidal stage pairs provides a seal that is 1.6 times higher than the pressure capacity of a seal having sixteen prior art double rectangular stage pairs. The pressure capacity of 113.4 pounds per square inch for the seal with sixteen trapezoidal stage

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pairs was surprisingly higher than the pressure capacity of 70.9 pounds per square inch for the seal having sixteen rectangular stage pairs.

Further, a comparison of the data in Applicant's Table 2 (single trapezoidal stage design) to the data in Table 3 (dual rectangular stage design) indicates that the single trapezoidal stage design provides a slightly greater pressure capacity than that of the dual rectangular stage design. This unexpected increase in pressure capacity is even more pronounced when the single trapezoidal stage design data is compared to the single rectangular design data. There is marked improvement of over 39 percent in seal pressure capacity. In light of the teaching in EP '656, one of ordinary skill in the art would not have expected this amount of improvement. On the contrary, one of ordinary skill in the art would have expected a slightly lower pressure capacity.

In light of the above arguments, Applicant respectfully submits that the 35 U.S.C. §103(a) rejections of independent Claims 1, 6, 11, 15, and 16 have successfully been traversed. Allowance of these claims is therefore requested.

Claims 3, 8, 12, and 17 of the present invention are also patentably distinct from the prior art because they claim a second pole piece with trapezoidal shaped ridges that are spatially opposed to trapezoidal shaped ridges on the shaft. This additional structure and configuration also provides for increased pressure capacity and, thus, is not taught in the cited prior art.

Claims 9, 13, and 18 of the present invention are also patentably distinct from the prior art because they contain trapezoidal shaped ridges having tapered sides that diverge away from a plateau portion to an annular region on both the pole piece and the

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shaft. This configuration is also not suggested in the cited prior art for increasing pressure capacity.

Claim 5, 10, 14, and 19 of the present invention are also patentably distinct from the prior art because they define the tapered sides of each, opposed, trapezoid shaped ridge to diverge at an angle between 0 degrees and 180 degrees. This configuration is not suggested in the cited prior art for increasing pressure capacity.

In light of the above arguments, Applicant respectfully submits that the 35 U.S.C. §103(a) rejections of Claims 3, 5, 8-10, 12-14, and 17-19 have successfully been traversed. Allowance of these claims is therefore requested.

CONCLUSION

Applicant respectfully submits that the amendments to the drawings, to the pending claims and the arguments presented herein successfully traverse the objection to the drawings, the 35 U.S.C. §112, second paragraph rejection as being indefinite, and 35 U.S.C. §103(a) rejection of Claims 1-19 as being unpatentable over Black et al. in view of European Patent 182,656 A2. Allowance of Claims 1-19 is therefore requested.

Applicant believes that all of the pending claims should now be in condition for allowance. Early and favorable action is respectfully requested.

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The Examiner is invited to telephone the undersigned, Applicant's attorney of record, to facilitate advancement of the present application.

Respectfully submitted,

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Robert R. Deleault

